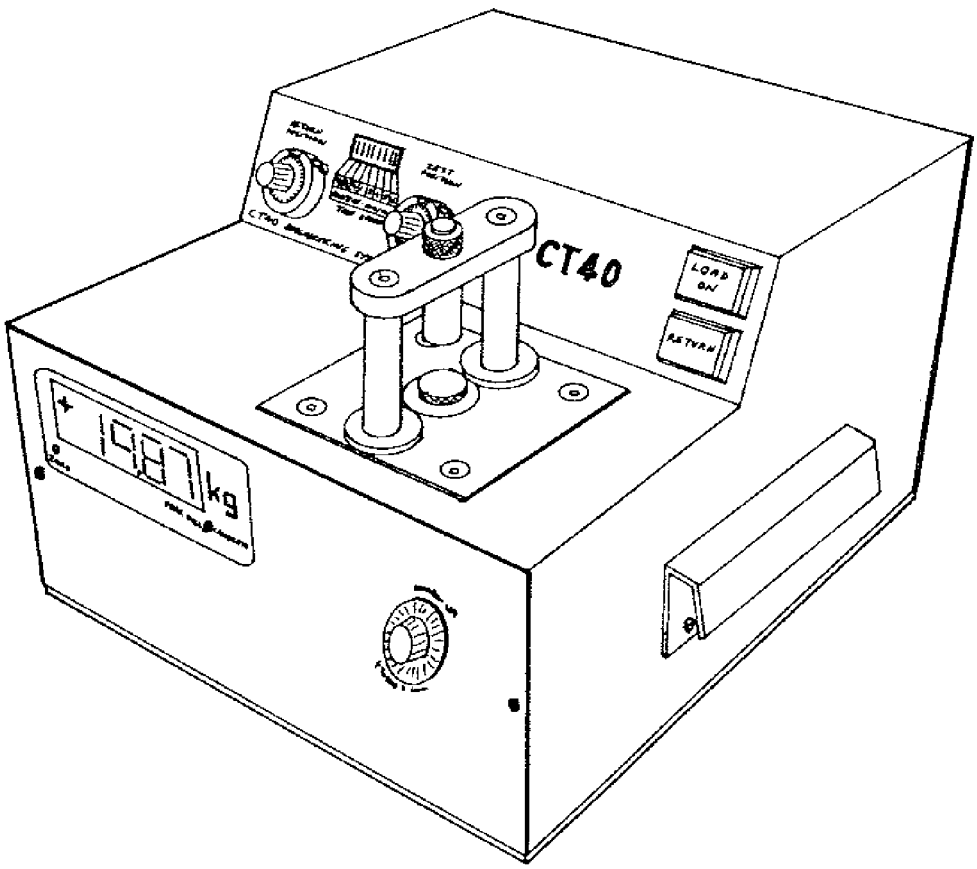
HANDBOOK

CT 40
MECHANICAL STRENGTH TESTER



ISSUE 12 APR '88

CONTENTS Page

Diagrams and Figures

1. The Machine

1.1 Specification (standard Machine)

Maximum load	40 kg*
Resolution	0.01 kg (10 g)*
Readout	Digital display in kg* (with peak and hold facility).
Analogue output	Terminals giving 1 volt/10 kg load*. Terminals giving a voltage proportional to crosshead displacement.
Testing speed	Variable between 1/8 and 31 7/8 mm/min. in 1/8 increments* and hand control using front plane knob.
Load cell deflection	0.5 mm at maximum load (0.05 mm for 250 kg cell)
Crosshead travel	30 mm
Platten size	15 mm*, top and bottom for compression testing
Power requirement	220/240V, 50 Hz, 1 amp. or) Selection by 110/120V, 60 Hz, 2 amp.) internal switch
Calibration	Weights or internal electronic calibration switch. Proving ring for 250 kg cell.
Machine weight	12 kg
Machine size	Height 180 mm width 290 mm depth 300mm

* Standard but can be modified to suit requirement.

1.2 Operating modes

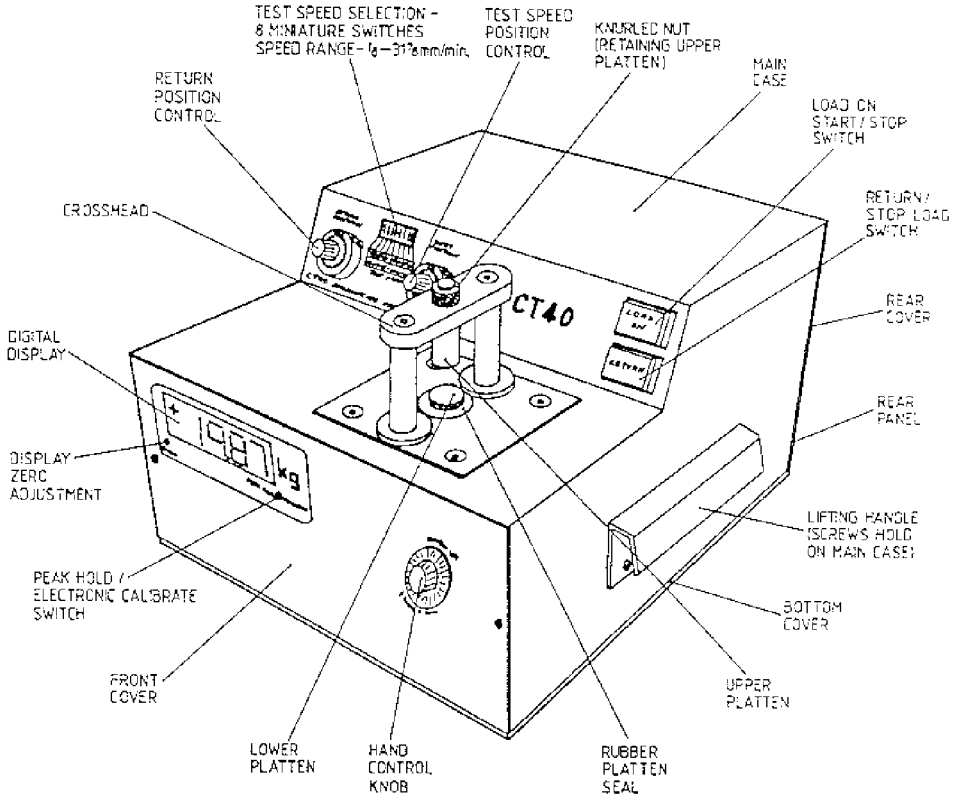
The machine was originally designed for the compression testing of pharmaceutical tablets. The latest version (CT40) can also be used for compression testing any small object and, with the addition of gripping jaws and pillar extensions, can be used for tensile testing small specimens.

In the CT40 designation, C denotes "compression", T "tension" and 40 is the capacity in kg of the machine fitted with the standard load cell.

1.3 Maximum loads

A range of 3 load cells is available for use up to a maximum load of 250 kg with a sensitivity of 100 g; or a maximum load of 5 kg with a sensitivity of 1 g.

CT 40 OPERATING ILLUSTRATION



REAR PANEL

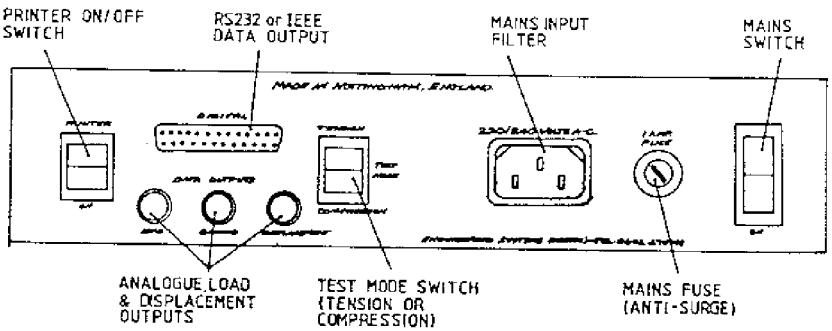
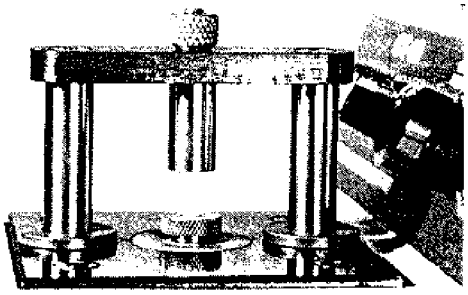


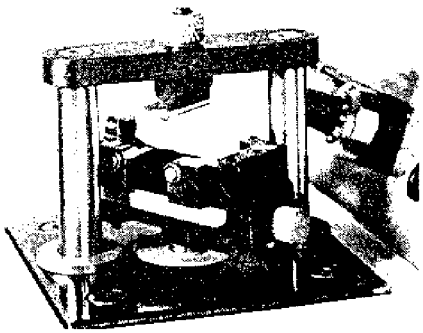
Figure 2

1.4 CT40 in use

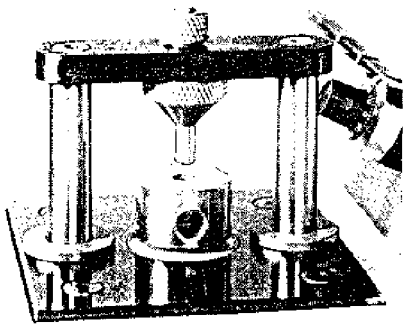


The CT40 in use for the measurement of the tensile strength, of pharmaceutical tablets, using the principle of the diametral compression test.

Shows the CT40 3 point bend attachment fitted and being used to test small rectangular bars.

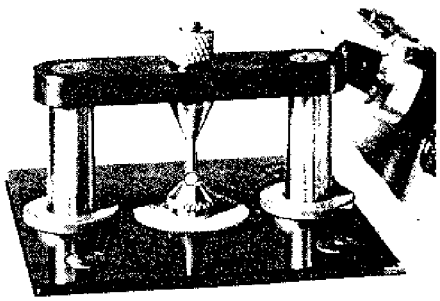


CT40 shown fitted with 'hole punch test plattens'.



The CT40 being used to test the mechanical strength of 6.3 mm saccharin tablets. The fracture load is often under 1 kg. but the resolution of 0.01 kg. enables accurate monitoring of the variation in tablet strengths.

If the optional 5 kg. load cell is fitted a resolution of 0.001 kg. is obtained.



2. Power supply and fuses

2.1 Power connection

The standard machine can be used on a 220-240 V, 50 Hz or 110-120 V, 60 Hz power supply. An internal switch (see figure 7, part 20) is set, before leaving the manufacturers, according to the country of destination. The set voltage is indicated on the lower rear back panel. If required the voltage supply can be changed by moving the switch, in which case the above indicated voltage, on the rear panel, should be erased and/or changed and the appropriate fuse inserted.

For convenience a detachable mains lead is supplied. The cable socket is for connection to the chassis plug in the rear of the machine and the square pin plug fitted with a 3A fuse is for connection to the U.K. mains supply.

CAUTION If moving, servicing or otherwise dismantling the machine, first disconnect the mains plug from the mains supply.

Persons qualified to check for electrical faults (i.e. electronic engineers) with the covers removed and mains connected, should note that AC mains voltage is not directly exposed anywhere throughout the wiring; but must beware of the high DC voltage potential of 60 volts supplied by the + and - 30 volt DC lines (pink and black wires) emitting from the power supply board.

Front cover removal only will not give direct access to the 30 volt supply and should be safe when making the internal adjustments described in section 4.2 and 5.3.

2.2 Fuses

A mains fuse is also fitted in the rear panel of the machine and if necessary can be replaced by unscrewing the fuse retaining screw. Use a 1A fuse for 220-240V and a 2A fuse for 110-120V, both 20 mm, anti-surge type fuses.

Three fuses are also fitted on the D.C. power supply board, this is located underneath the base plate. To gain access remove the bottom cover (4 fixing screws) and see Fig. 7, (component layout). These fuses are 2 @ 1.6A and 1 @ 2A, each 20 mm, anti-surge types.

3. Operation

The operating switches, dials, and indicators are situated on the front sloping panel. A hand control knob is located to the right of the front panel.

Some electronic measuring circuits take time to warm up. For convenience, it is recommended that the machine be switched on at least half an hour before required, otherwise the 'zero' and 'range' may need to be adjusted.

3.1 Illuminated switches and indicators

3.1.1 Load on switch (green)

This switch, when pressed, latches on electronically and starts the motor, which drives the crosshead. The machine incorporates an electronic fracture detect facility which automatically stops and reverses the motor when the specimen has fractured. The automatic cut out will also operate if the maximum load or the maximum allowable travel is exceeded.

3.1.2 Return (blue)

When the return switch is illuminated the crosshead is being returned. The crosshead is automatically returned to its preset position (see 3.2.1) when either a fracture, or over-range, or over-travel is detected. The crosshead can also be returned during loading or, to a new higher preset position, at any time by pressing the return switch.

3.2 Crosshead controls

The crosshead is driven in the sequence:- fast forward, test speed and fast return speed.

3.2.1 Crosshead return position control

The 3 turn dial mechanism (see fig. 2) sets the distance between the loading plattens when the return cycle has been completed. The maximum travel is approx. 30 mm, therefore one complete turn of the ten turn dial mechanism will vary the distance setting by approximately 10 mm.

3.2.2 Crosshead test speed position control

Similarly this dial sets the position at which fast forward speed changes to test speed.

Setting this dial to a larger value than the return position dial will disable this facility.

3.2.3 Test speed

Test speed is set by the appropriate combination of switches in the 8 gang switch, the switch setting is additive. Any speed between 1/8 and 31 7/8 mm/min. may be set in 1/8 mm/min. steps.

3.2.3.1 **Test speed range adjustment**

Test speed can be checked by using a stopwatch and a rule or a dial indicator to measure the crosshead movement in unit time. Alternatively, revolutions of the hand control knob can be counted; 4 revolutions represent a crosshead travel of 1mm.

If the measured speed does not match the set test speed, adjustment is provided on the speed selector board, see fig 11.

3.2.3.2 **Speed range change by gearwheel adjustment**

The speed range may be changed by changing the gearwheel ratio between the motor and the load frame. The standard reduction ratio from the gear train (4 gear wheels) is 12:1, the maximum ratio obtainable is 25:1, giving a slower speed but a high available torque which is necessary when testing up to 250 kg. The top speed can be doubled using a ratio of 6:1 in which case the torque, i.e. the maximum test load, is restricted especially at low testing speeds.

Supplementary fitting instructions will be issued if additional gear wheel sets are supplied, but it is recommended that the machine be returned to Engineering Systems.

3.3 **Hand control knob**

When the motor is switched off the loading beam can be raised or lowered by turning the hand control knob located to the right of the front panel. When using this knob it is possible to exceed the maximum load or the maximum travel of the machine and care must be taken not to over-range when using this knob, otherwise damage could occur.

3.4 **Statistics operation (if fitted)**

3.4.1 **Cancel**

Pressing the red button situated under-neath the printer cancels the last recorded sample reading.

3.4.2.**Statistics**

Pressing the green button gives a print out of the statistical data and the time and date. See section 5.2.

3.5. **Testing**

Caution:- Some materials may fragment during testing and some form of eye protection may be necessary. Goggles may be worn or a transparent cover surrounding the loading beam and plattens could be installed.

3.5.1 **Compression Testing**

Set the Comp./Tension switch (rear panel) to Compression.

If the 'daylight' between the plattens is not large enough to accommodate the specimen, turn the return position potentiometer to a larger value (1 turn is approx. 10 mm). Set the peak hold switch to peak hold; for convenience turn off the printer (if fitted). Press the return button whence the crosshead will return to its new set position.

Place the test object centrally onto the lower platten and set the test speed to zero. Set the test position dial to a larger value than the return position dial and press the load on switch. Gradually decrease the test position dial until the upper platten has moved close to the test object, switch in the required test speed, the specimen will now be tested, the fracture load displayed and the crosshead returned to its pre-set position.

3.5.2 **Tensile testing**

Tensile testing requires special attachments to grip the specimen. Standard attachments are not supplied but are individually designed to suit the specimen material and shape.

Set the Comp./Tension switch (rear panel) to Tension.

The automatic return and the fast forward modes of operation should be disabled by turning the crosshead return position control dial to is minimum position and the crosshead test position control dial to its maximum value.

Tensile testing can now be carried out using the hand control knob to position the gripping jaws etc. relative to the specimen.

To give even loading when measuring small loads (under 5 kg) it may be necessary to disconnect the tension springs from the bottom load frame beam.

4. Front panel controls and adjustments

4.1 External controls

4.1.1 Zero adjustment

The small hole located just below and to the left of the digital display provides the zero adjustment for the digital display. A small insulated screwdriver or trim tool is required for these adjustments. If the display does not show zero the tool should be inserted into the zero hole and the internal screw turned until the display is 'zeroed'.

4.1.2 Peak hold/calibrate switch

This is located just below and to the right of the digital display. It is a toggle switch with three positions; left position switches the peak hold facility on, right position is for electronic calibration and centre position is off.

4.1.2.1 Peak and hold facility

When the peak hold/calibrate switch is off the digital readout follows the load cell output during the test and if fracture of the specimen occurs, the readout will fall to zero in a tensile test or, in a compression test, to some value depending upon the specimen material properties.

When the peak and hold facility is switched on, the digital readout will follow the increasing load but will not fall when the specimen fractures. The maximum load reading is held and can now be recorded. If complete failure has not occurred and the test is continued, it is possible that the previous peak reading will be exceeded; the display will then follow and hold the new peak reading. For convenience of operation during a series of tests the peak reading is held when the loading cycle ends and automatically reset to zero when the motor is restarted. Alternatively the peak and hold facility can be reset by switching the peak and hold switch off and on again.

The electronic circuit which holds the peak reading is only stable for a limited period of time and the displayed peak reading may fall 1 digit every 30 seconds after the completion of a test.

If the peak and hold switch is on when the machine is first switched on, an over-range may be indicated. This can be cleared by switching the peak hold switch off and on again.

4.2 Internal adjustments

The majority of the internal adjustments are multi-turn potentiometers located on the amplification and digital display board.

Before attempting any internal adjustments with the power switched on read the note of CAUTION under heading 2.1

To gain access to these adjustments remove the front panel, (when fitted first remove the hand control knob by loosening a grub screw) by removing the two small screws either side. If necessary, adjustment, using a trim tool, of the 20 turn potentiometers 2, 3, 4, 5 and 6 may be carried out by competent persons. The other potentiometers should not be adjusted. (see Fig. 3).

4.2.1 Adjustment of functions

Adjustments of Pot 1 (see Fig. 3), zero was described in Section 4.1.

4.2.1.1 Range

This adjusts the range of digital output to correspond to the applied load. The range is adjusted by inserting a tool into the small hole marked 'range' and turning the screw in the required direction.

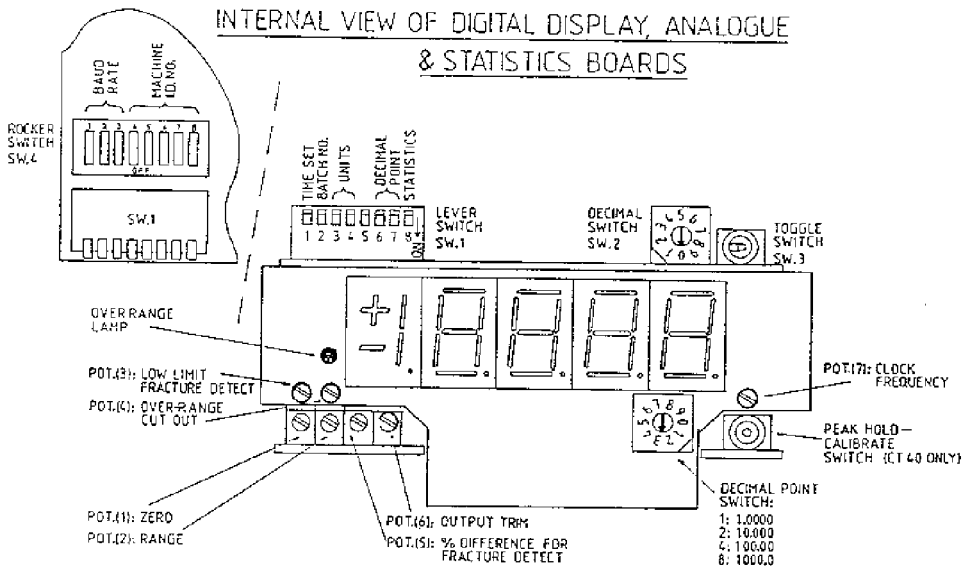


Figure 3

4.2.1.2 **Calibrating procedure**

Calibration is carried out initially by dead weight loading of the platten. (proving ring for 250 kg Load cell).

4.2.1.3 **Calibration by dead weight loading**

Switch the Peak hold/Calibrate switch to its central position.

Set the digital reading to zero and remove the loading beam with the aid of a 3 mm hexagon socket key. Load the bottom platten with a series of suitable weights i.e. 10 kg, and adjust the range until the digital readout corresponds to the value of the applied weights. Remove the weights; the display should read zero. If the zero reading is in error, re-set and again load the platten with weights and re-adjust the span. Repeat this procedure until the display reads correctly with the without weights.

4.2.1.4 **Electronic calibration**

Switching the peak hold/calibrate switch to the calibrate position connects a high stability resistor into the load cell circuit and gives an apparent load reading on the digital display.
When calibration by dead weight loading has been completed (weights removed) the calibrate value should be noted and the value of the readout noted.
Future calibration can be carried out by using the calibrate switch; the digital readout should correspond to the value of the readout noted above.
Calibration using dead weight loading should also be carried out from time to time.

4.2.1.5 **CT40 Calibration using proving ring (250 kg load cell)**

1.) Remove lower platten and the upper platten also remove the crosshead beam from the loading pillars.

2.) Fit extension pillars and replace crosshead onto the extensions.

3.) Reset the lower end of the proving ring into the load cell recess, place the ball bearing into the recess in the top of the proving ring and lower the crosshead until there is just no load applied.

4.) Zero the display.

5.) Apply load at ⅛ or ¼ mm/min (or at a faster speed), stop loading at the required increments, check the calibration and adjust if necessary.

6.) Make a note of the new electronic calibration value.

Note :- It may take some practice to use the proving ring for this calibration sequence.

4.2.3 **Output trim, pot 6**

This adjusts the load cell analogue output voltage to match that shown on the digital display. This should be checked before attempting any further adjustments. A voltmeter, set to read 10 volts maximum, should be connected to the load cell output terminals on the rear panel, polarity must be observed. Zero if necessary (described in 4.1.1), set the peak hold/calibrate switch to calibrate, the digital display on the CT40 should read the same as the reading shown on the voltmeter. If in error, turn pot 6 until the readings match.

4.2.4 **Low limit fracture detect suppression, Pot. 3**

The % fracture detect facility will not operate satisfactorily at very small loads i.e. a fracture would always be detected at zero load and the machine would fail to start. The low limit cut-out presets a load below which the motor will not be stopped if an apparent fracture is detected. False fractures may be detected if the setting is too low and some experimentation may be necessary to determine a satisfactory level for the minimum setting. A suggested setting for the standard 40 kg machine is 0.30 kg.

Checking the low limit setting. For convenience remove the loading beam, with the peak hold switch on, press the load on switch. Apply, by hand, a small load, i.e. 0.10 kg to the lower platten and allow the load to return to zero. Repeat this procedure a number of times, gradually increasing the load until the motor stops. The low limit load will be displayed on the digital display.

Adjusting the low limit setting. Turning Pot. 3 clockwise decreases the minimum load.

4.2.5 **% Difference for fracture detect Pot 5.**

Fracture is detected and the crosshead motor is stopped when the instantaneous load measured by the lower platten falls below a preset % of the maximum load (i.e. the peak held load) attained during testing. The fracture detect pot (5) can be adjusted to give any fracture detect % up to 100% (Typically 60%-70%).

Checking the % setting. For convenience remove the loading beam, connect a digital voltmeter set to read up to 10 volts D.C. into the load cell output terminals (see Fig. 2).

With the peak hold switch on, press the load on switch (i.e. crosshead moving down). Slowly depress the lower platten by hand to obtain a reading of say 2 kg, gradually release the pressure on the platten until the motor stops. At this point (and without further releasing the load on the lower platten) note the reading displayed on the external digital voltmeter. Comparison of the peak held load and the digital voltmeter reading gives the % fracture detect setting.
Note : some practice may be required before consistent percentages are obtained.

Adjusting the % setting. Turning Pot. 5 clockwise decreases the % setting.

4.2.6 **Further consideration of the % fracture detect and low limit settings.**
(see also section 4.2.4 and 4.2.5)

The following graph shows the relationship between Low Limit load, % Fracture Detect, Peak Hold load, Test Load, Load Cell Load and Fracture point during a typical test. (Time is proportional to test speed.)

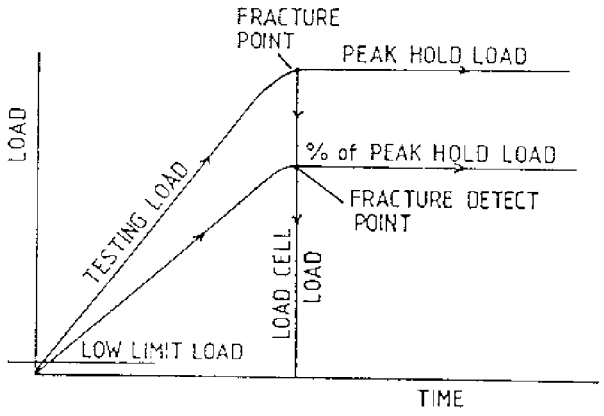


Figure 4

On loading the peak held load follows the load cell load up to the point of fracture, at this point the load cell load drops to zero (unless the test object is spongy or crumbly) and the peak held load remains constant. Fracture is detected by the electronic circuitry when the load cell load crosses the % peak hold load line (or setting). The usual % setting for this 'line' is 60-70% but the material properties of some test objects may demand a revised setting before meaningfull test results can be obtained.

Soft crumbly objects may require a lower % setting because the testing load may drop momentarally (causing a fracture detect) during loading, due to localised surface crumbling prior to the object fracturing or substantially failing. Some experimentation will be required to obtain a satisfactory % setting for these 'difficult' materials. A fracture may not be detected at all if too low a % setting is used, the test object may just be gradually crushed into a powder. Different platten geometries i.e. convex, may have to be considered.

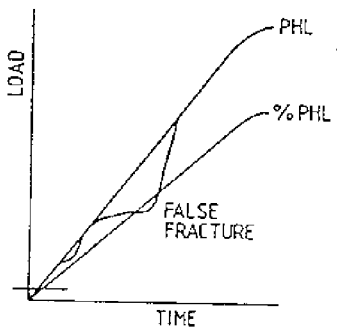


Figure 5

Hard objects in compression may fracture but leave ½ of the fractured test object in the test position between the loading plattens. If the % setting is too low a fracture will not be detected. If the setting is too high, small departures of the load cell load from the peak held load (especially at the start of a test, see 4.4) will give a fracture detect and the test will be halted.

5. Printer (if fitted)

The printer automatically prints the peak reading at fracture, as indicated on the digital display. A test identification number precedes each reading. The maximum identification count is 99. If the statistics pack is not fitted, before testing a new batch of items set the printer to start counting at 1., by interrupting the power supply to the machine, i.e. switch the mains supply off and on again. See below.

IMPORTANT Wait at least 10 seconds before switching the mains ON after switching OFF otherwise the microprocessor controlled printer may receive erroneous signals and incorrect operation and irreparable damage to the printer mechanism may result.

The printer ON/OFF switch inhibits the printer from printing but will not reset the identification count and the drive electronics will continue counting when receiving fracture detect signals even with this switch OFF.

5.1 Changing the paper roll and cartridge ribbon (Fig. 6)

The printer has to be removed from the machine to change the paper roll or the cartridge ribbon. Before removing or replacing the printer, the mains supply must be switched OFF otherwise the printer electronics may be damaged. Remove the printer with care by unscrewing the two lower knurled printer screws and easing the printer from its recess, care must be taken not to damage any of the components situated near the top rear of the printer. Disconnect the 5 way flying lead connector.

The printer mechanism is the EPSON M150 unit, spare paper rolls and spare ribbon cartridges should be available worldwide. If in difficulty contact Engineering Systems.

5.1.1 Paper loading

Use only 44.5 mm wood free, high quality paper; maximum diameter 50 mm, internal diameter 13 mm.

IMPORTANT NOTICE:

Take care that paper changing is not carried out in areas subject to static. Touching the connector contacts, etc. of the printer under very adverse conditions could cause damage to it.

Turn printer over and remove paper pivot bar (2) by unscrewing a third knurled thumbscrew (taking care not to lose nylon washer) and withdrawing paper pivot bar. Remove any old paper, cardboard roller and discard.

Prepare a fresh roll of paper by cutting a shallow "arrow head" at its start. Place roll in paper holder region and insert paper pivot through centre, as shown in Fig. 6. Fasten paper pivot with knurled thumbscrew and nylon washer (finger tight only). Straighten first 20 mm paper over paper guide (3) and insert into printer, correctly centred. Push in as far as it will go.

5.1.2 Ribbon cartridge replacement

After approx. 10 paper rolls have been used, the ribbon cartridge will need replacement. Remove the printer from the C40 as described above but it is not necessary to remove paper.

Unscrew two pozidrive screws (4) and washers on printer front panel. Remove panel exposing printer mechanism, the ribbon cartridge (5) will now be clearly visible. Taking note of ribbon and paper arrangement, depress cartridge where indicated. Cartridge will tip up and may then be removed and discarded. Insert replacement cartridge, tensioning ribbon if necessary by turning knurled wheel on cartridge in direction indicated. Replace front panel.

Switch ON and depress FEED button (1) when printer will start to feed paper. Check that paper emerges correctly from aperture. The unit is now ready for use.

PAPER AND RIBBON REPLACEMENT

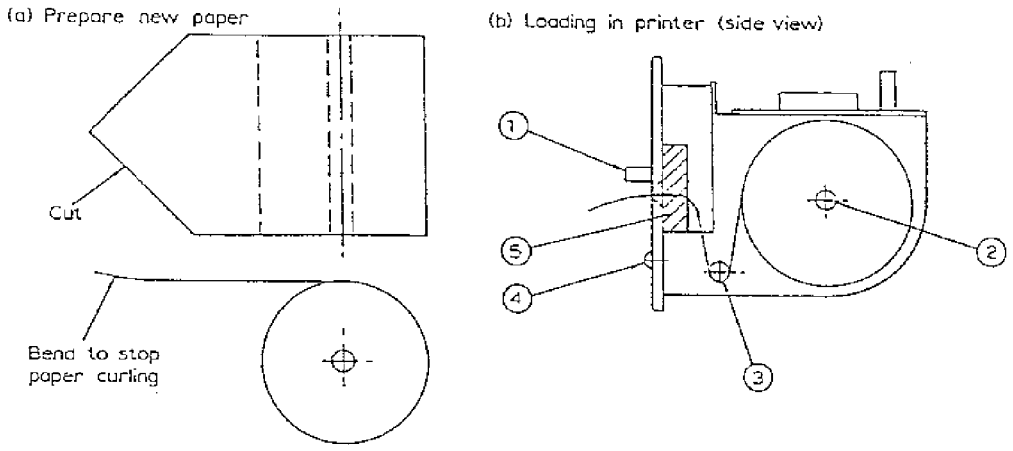


Figure 6

5.2 Description of the statistical package

This optional addition to the C40/CT40 range of testing machines enables the integral printer to automatically print statistical information from batches of tests in an easy to read form which includes the Date and Time.
A typical printout is:-

```
BATCH NO.


MACHINE NO. 15
MON 02-03-1988
TIME  14.30
MEAN     = 03.07
STD.DEV = 00.65
MAXIMUM = 04.12
MINIMUM = 01.98
UNITS:KILOGRAMME

   07  03.02
   06  02.87
   05  03.42
   CANCEL 05
   05  00.03
   04  02.84
   03  04.12
   02  01.98
   01  03.26
```

Batch No. A reminder for the operator to write the BATCH NO. on the print out. This print out can be inhibited.
Machine No. - a useful identification facility where there are a number of testing machines within a factory. Can be set to print any number up to 31, a zero setting inhibits the Machine No. printout.
Date and Time - an internal battery with a life of approx. 10 years enables the internal clock to continue to update the date and time when the machine is switched off. A time change facility is provided; in the event of BST or time drift over a period, the time can be reset.
Statistics printout etc. is enabled by the operator pressing a button (membrane switch) located on the front of the machine, this button is not easy to press accidentally.
Units can be changed to read either:- NEWTONS, KILOGRAMME, KILO POND or STRONG COBB. The calibration must also be changed to suit.
Sample data is printed automatically, preceded by an identification No., when a fracture is detected by the machine.
Cancel The last reading can be cancelled, the next reading takes the No. of the cancelled reading.
Data can be output via. the RS232 output socket located at the rear of the machine. The option exists to output (at the end of the day) the day's data readings to a suitable hand held, data capture type computer.

5.3 Operating instructions for the statistical package

When the machine is delivered the package is ready for use without any adjustment. However, various options and adjustments are incorporated into the statistics board. This board is located just above the digital display (see Fig. 3) and before any adjustments can be made the top cover has to be removed (see section 4). Figure 3 shows the position of the adjusting switches which are designated the following no's and names:-

SW1. 8 way lever switch (left hand side)
SW2. Decimal switch (right of centre)
SW3. Biased toggle switch (right hand side)
SW4. 8 way rocker switch (not visible but immediately to the rear of switch 1)

The adjustments which can be carried out are:-

Resetting the clock	SW1, SW2, SW3
Batch No.	SW1
Units.	SW1
Decimal point position.	SW1
Statistics and clock disable.	SW1
Baud Rate.	SW4
Machine identification.	SW4

5.3.1 Lever Switch No.1

This lever switch is clearly visible and positioned just above the + sign on the digital display.
The levers are UP for OFF, and DOWN for ON.

5.3.1.1 Time set enable

Position 1. ON, (down) enables the clock time to be reset or changed.

5.3.1.2 Batch no.

Position 2. ON, gives a print of Batch no. and two line feeds at the start of a new batch.

5.3.1.3 Units

The units are selected using positions 3 and 4

Pos. 3	Pos. 4	Units
0	0	Kilogramme
0 (UP)	1 (DOWN)	Newton
1	0	Kilopond
1	1	Strong Cobb

Note :- the switch setting only changes the print out, the machine has to be re-calibrated to match the print out. See section 4.1

5.3.1.4 Decimal point position

This is set by positions no 6 and 7 and only changes the decimal point position on the printer print-out. The D.P. position on the digital display is changed using the lower decimal point decimal switch, Fig 3. With a small screwdriver or trim tool, move the central pointer to give the correct decimal point position.

Pos. 6	Pos. 7	Decimal point position
0	0	0000.
0	1	000.0
1	0	00.00
1	1	0.000

5.3.1.5 Statistics and clock disable

Position 8 disables the statistics, i.e. to enable the statistics package to work, the switch must be down (ON). If the statistics are disabled, the printout is reset to zero by switching the mains switch OFF, then ON.

IMPORTANT - leave an interval of 10 seconds before re-switching ON.

5.3.2 **Rocker Switch No.4**

This rocker switch is situated behind the lever switch (5.3.1) and can be accessed when the display and statistics boards are removed from their housing. The switches can also be reached with a small bent rod; if changes are to be made using this method the machine should be switched off, as the changed switch position will not be recognised until the machine is initilised by switching on, from the off position.
OFF, on this switch, is with the rocker down at the front.

5.3.2.1 **Baud Rate**

If required the Baud rate is variable from 75 to 9600 Baud; but, if the baud rate is changed, the printer baud rate also has to be changed. The printer is limited to 4 baud rates :- 300, 600, 1200 or 2400. The printer baud rate change is by soldered connections on the printer, refer to the printer manual (supplied separately) for details.
The baud rate is changed on the statistics board by setting switch positions 1, 2 and 3 on rocker switch no.4.

Pos.1	Pos.2	Pos.3	Baud Rate
0	0	0	75
0	0	1	150
0	1	0	300
0	1	1	600
1	0	0	1200
1	0	1	2400
1	1	0	4800
1	1	1	9600

The printer is set to work at 2400 baud, therefore for normal operation positions 1, 2 and 3 on rocker switch 4 should be set to ON, OFF, ON respectively.

5.3.2.2 **Machine identification number**

Machine identification numbers between 1 and 31 can be selected using positions 4 - 8 of rocker switch no.4. If all these switches are set to zero then MACHINE NO. is omitted.

Pos.4	Pos.5	Pos.6	Pos.7	Pos.8	Machine no.
0	0	0	0	1	1
0	0	0	1	0	2
1	1	1	1	0	30
1	1	1	1	1	31

5.3.3 Setting and resetting the clock

After the top cover (main box) has been removed reconnect the printer so that the printer rests on the bench top just in front of the machine
IMPORTANT NOTE - The machine must *always* be switched OFF when the printer is either being connected OR disconnected. Damage to the printer may result if this precaution is not observed.
When position 1, switch 1, is ON, (down) the clock can be reset.
This switch must be switched OFF (up) for normal operation.
The clock does not update the time whilst in the reset mode, resetting position 1 (to OFF) on the lever switch re-starts the clock.
When the above switch is ON the clock can be reset using Decimal switch (SW3) and Toggle switch (SW2) which are both situated above the least significant digit (right hand display digit).

The sequence of setting the clock is :-

Minutes, 10's Minutes;
Hours, 10's Hours (24 hr. clock);
Day (1=Mon, ... 7=Sun);
Date, 10's Date;
Month(1=Jan), 10's Month;
Year, 10's Years.

These are set in order and the minutes can be changed without having to change the hours etc. (but the minutes have to be set before the hours can be set). To change the time; set position 1, switch 1 to ON (down), the printer will now print out the current time and date. Set the decimal switch (SW2) to the units of minutes and switch the toggle switch (SW3) to the left. The printer now prints the new time. If further resetting of time is required, wait until the printer has stopped printing and continue the sequence, setting the decimal switch to the ten's of minutes and repeat switching the toggle switch etc. The clock setting procedure can be terminated at any time by switching position 1 (switch 1) OFF. A continuation will enable the setting of the Hours, Day's etc.

e.g. The clock is to be completely reset to:- 2.30pm, Monday 2nd March 1988
The best way to avoid making a mistake is to write out the numerical data in reverse i.e.

1988	March	2nd	Monday	24hr time	Minutes
88	03	02	1	14	30

The data string is presented to the clock in order, starting with 0, followed by 3 then 4 etc. and toggling each value into the clock after printing has stopped.

If it had only been required to change the minutes; set 0 and 3 (or whatever value of minutes is required) and toggle each into the clock then switch position 1 to OFF (up).

6. Rear panel outputs

6.1 Load Cell Output

This is discussed in 4.2.3. This output is available on the rear bottom panel and can be used to drive a variety of independent recording devices, i.e pen recorder, U.V. recorder, etc. It is independent of the setting of the peak-hold switch. i.e. this output follows the value of the load applied to the loading platten. An output of 1 volt/10 kg (standard load cell) load is given at these output terminals. It should be noted that the low (black) output is connected to the chassis i.e. earthed. Some external equipment may also have the low terminal earthed and care should be taken when using these terminals to ensure that the correct polarity connections are made.

6.2 Crosshead displacement

This output is not internally adjustable and an output voltage in the range 0 - 12 volts is given at these terminals, the low (black) terminal is earthed and the voltage output is proportional to the position of the crosshead.

6.3 Digital output

An RS232 compatable, or an IEEE-488 interface can be fitted as an optional extra.

6.3.1 RS232 Data

If fitted the 25 way D type connector provides the RS232 compatible output generated by the printer/statistics interface board.

This data is transmitted only when a fracture is detected or the statistics information is being printed.

The data is transmitted in the format:-
1 Start bit, 7 Data bits, 2 Stop bits, at the rate of 2400 bits/sec. (see section 5.3.2.1). A line feed only (no carriage return) is given at the end of each line.

The CT40 is configured as a TERMINAL device but is fitted with a female 25 pin connector.
RS232 out, is transmitted from the CT40 on pin 2. (7 is ground)
RS232 input, is on pin 3.
Correct polarity of externally connected equipment must be observed.
The remaining pins on the 25 way connector are not connected.

6.3.2 Data capture with external equipment

For machines fitted with EPROM 1A, data appears at the RS232 output at the same time that it is printed on the printer, the batch data is removed from the internal memory (RAM) each time the statistics are printed.

Machines fitted with EPROM 1B will store data until the internal RAM is full and then overwright the oldest data. The stored data can be removed by using a hand held computer such as the PSION ORGANISER II. This data can then be passed on to a mainframe or personal computer for storage and/or further manipulation.

Statistical Process Control (SPC) can also be carried out by the hand held computer if it left permanently connected to the CT40.

7. Dismantling procedure

First remove the mains lead cable socket from the chassis plug in the rear of the machine.

The mechanical and electronic components are mounted on an aluminium alloy base plate which is contained within the outer casting.

This case consists of four separate removable parts, i.e. Main case, Front panel, Rear top panel, Bottom cover. These can be removed as follows :-

Bottom cover. Remove the three pozidrive screws from the rubber feet and lift the machine clear of the bottom casing.

Front panel. Remove the hand control knob using a suitable screwdriver, then unscrew the two pozidrive retaining screws (one each side, half way up). The panel can now be removed.

Rear panel. Remove the two pozidrive screws located towards the top of the white panel. Tilt this panel outwards from the top and lift off. The black bottom panel is a permanent fixture and no attempt should be made to remove this.

Printer (if fitted) See section 5.1 for removal instructions.

Main Case. First disconnect the plug which connects the sloping front panel controls to the main frame; this is located centrally just above the rear adjustable foot. When the wire clip has been pushed to one side, the plug can be lifted off.

The main case is attached to the main frame by 4 slotted screws (2 either side) which also hold the handles in position. When these have been removed the case can be lifted off.

For reassembly it should be noted that the case fits **between** the base plate and the rear bottom black back plate.

7.1 Loading plattens

The top and bottom load plattens may be removed if required. The bottom platten can be unscrewed by hand and the top platten is loosened by unscrewing the top knurled retaining nut.

7.2 Changing the load cell

Dismantle casing as described above.

Remove crosshead, lower platten and load cell top plate.

Remove load cell and fit new load cell.

Centre new load cell by fitting crosshead, upper platten and lower platten and ensuring that both plattens are concentric.

Remove crosshead and refit load cell top plate, lower platten and crosshead.

Re-connect power to CT40. Adjust decimal point to suit new load cell (rotary switch on bottom right of display panel), zero the display, set the range (i.e. calibrate as in 4.2.1.1.) and check the new switch, adjusting the zero potentiometer so that the load cell maximum value is displayed and then adjusting pot (4) (see fig. 3) so that the over-range lamp **just** comes on; switch off calibrate and re-zero.

Refit main box, back panel, bottom cover, front panel and hand control knob.

Check operation of machine.

8. Component parts

The following parts list, component layout and circuit diagrams show only the major parts. Small items such as individual screws etc. are not listed.

Parts List

1. Load Frame
2. Crosshead
3. Knurled Nut - retaining Upper Platten
4. Rubber Platten Seal - sealing in Lower Platten
5. Motor Power Amplifier
6. Load Cell
7. Linear Displacement Potentiometer
8. Reduction Gearing (under cover)
9. Motor - Tacho Unit
10. Linear Potentiometer Connector
11. Motor - Tacho Connector
12. Printer / Main Case Connector (when fitted)
13. Main Case to Base Plate Connector
14. Display Circuit Board (ESB 25 8806)
15. Peak Hold / Electronic Calibration Switch
16. Output Connector for Interface Boards
17. Analogue to Digital Circuit Board (ESB 6F 8724C)
18. Trimmer Potentiometes - RV9, 10 & 11
19. Analogue to Digital Board Edge Connector
20. Mains Input Voltage Selector Switch
21. Torroidal Transformer (3A792P)
22. Power Supply Board Output Connector
23. Power Supply Circuit Board (ESB 17A 8704)
24. Power Supply Board Fuse - 2.5A 20mm anti-surge
25. " " " " - 1.6A 20mm anti-surge
26. Power Supply Board Input Connector
27. Motor Power Amplifier Connector
28. Displacement Potentiometer Extension Plate
29. Gear Cover
30. Control Circuit Board (ESB 14D 8708)
31. Control Board Edge Connector
32. Printer On / Off Switch
33. Analogue Load Output Socket
34. Digital Data Output Connector
35. Analogue Ground Output Socket
36. Analogue Displacement Output Connector
37. Tension / Compression Test Mode Selection Switch
38. Mains Filtered Input Connector
39. Mains Input Fuse Holder
40. Mains On / Off Switch

CT 40 COMPONENT LAYOUT

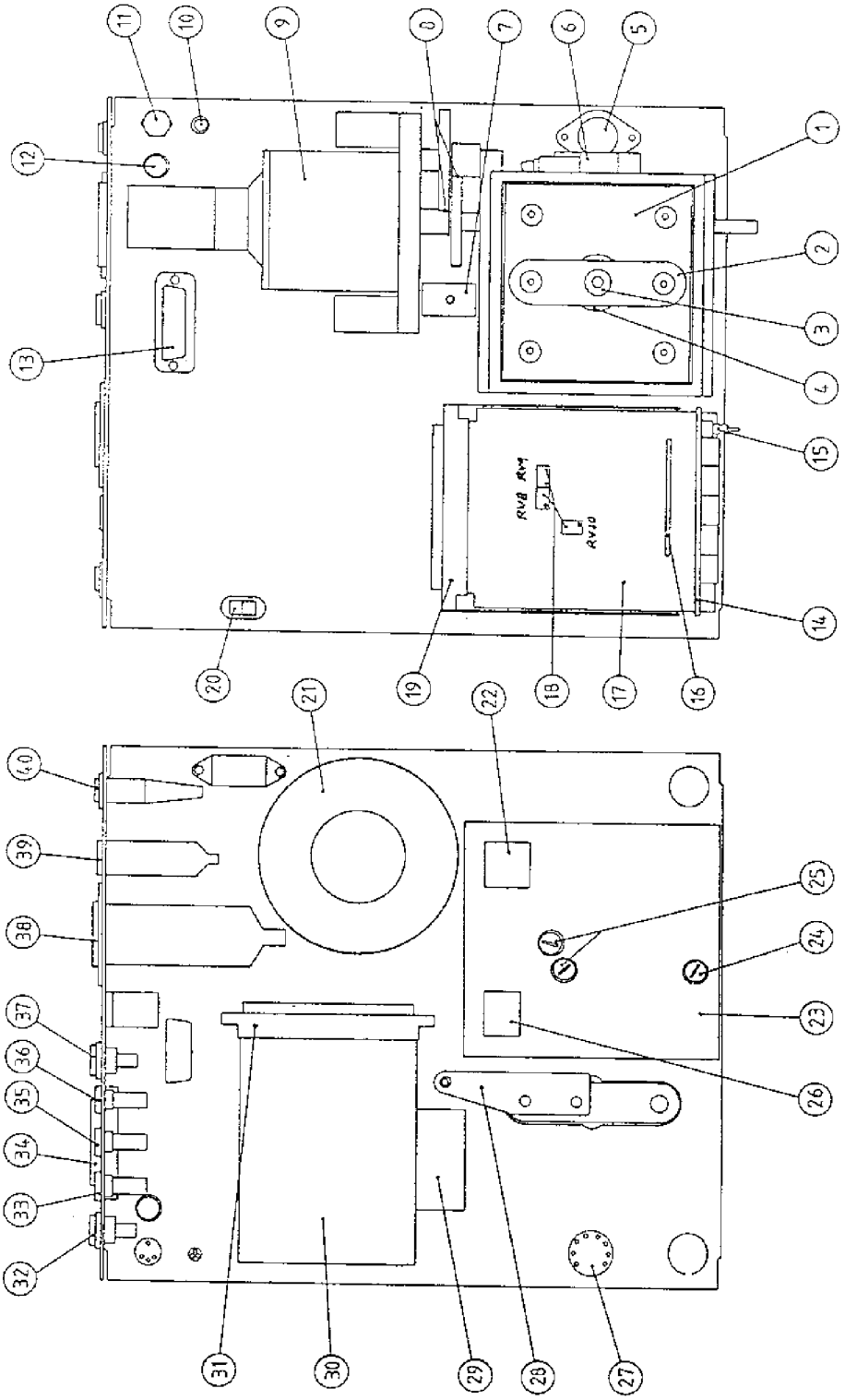


Figure 7

8.1 ELECTRONIC BOARDS FITTED

There are 7 boards fitted to the CT40 machines, these boards are identified by a name and number. The name is self explanatry, the number is composed as follows:-

ESB stands for Engineering Systems Board
The NO. eg. 16, is the numerical order of the original Engineering Systems Board design.
The LETTER, eg, D, is the current update mark.
The Numbers, eg. 8717 give the date on which the board was designed or last updated. i.e. Week 17, 1987

Speed & Position Control	ESB 16D 8717
Motor Control	ESB 14D 8708
Power Supply	ESB 17A 8704
Analogue	ESB 6F 8724C
Digital Display	ESB 25 8806
Connector for ESB 6F to ESB 22	ESB 23 8709
Statistics + RS232 & Printer	ESB 22 8704 Issue C

In addition there is an EPROM situated on ESB 22

EPROM	ESE 1A 8709

The torroidal transformer which is is fitted is designed and manufactured to Engineering Systems specifications. Torroidal transformers are more efficient, smaller and most important, give less electromagnetic interference than a conventional transformer. The penalty is a higher unit cost.

Torroidal Transformer	3A792P

8.2 SERIAL NUMBER

The serial no. is to be found on the top side of the base plate behind the rear cover. This number should be quoted in any correspondence regarding the machine.

Serial No. .....

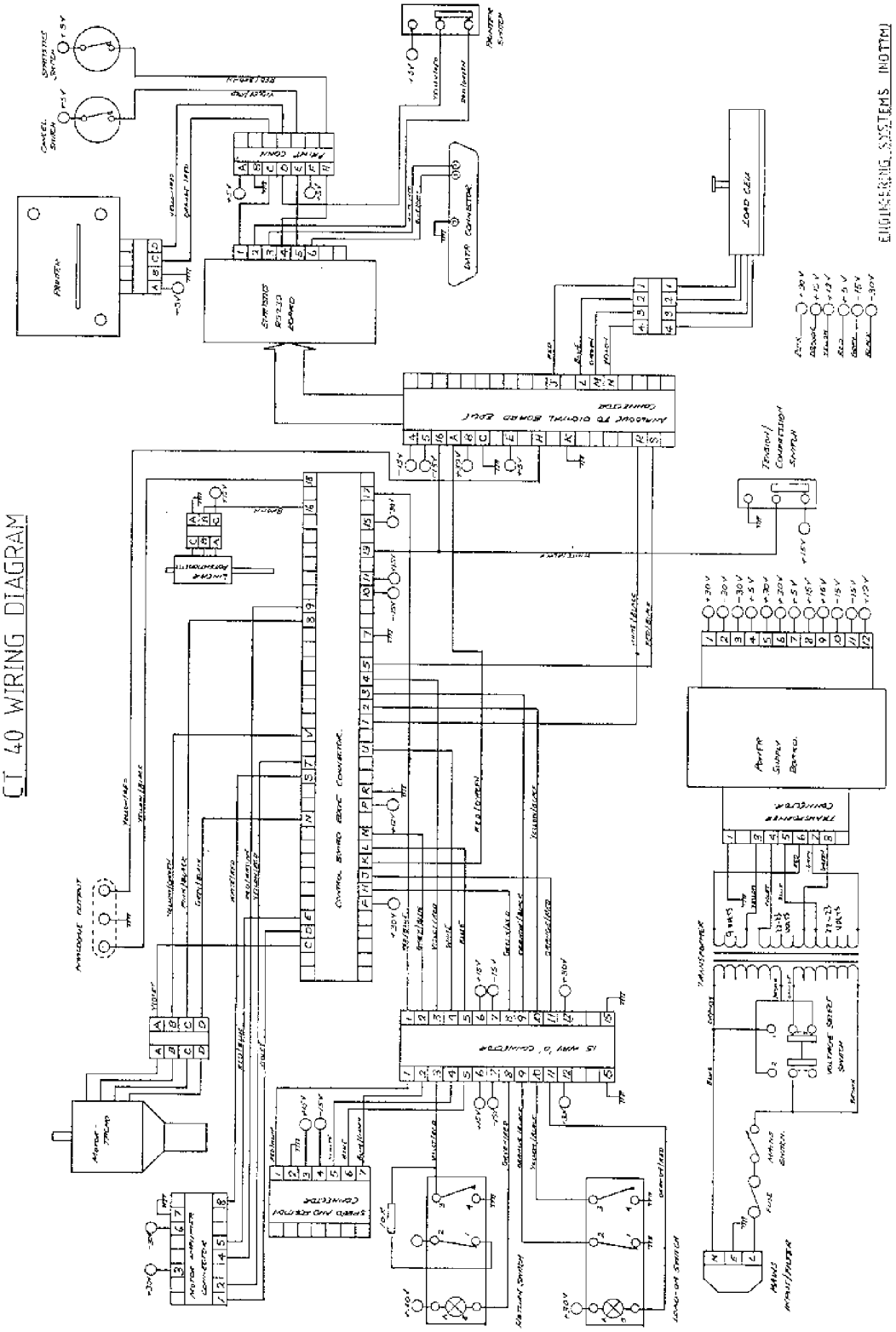


Figure 8

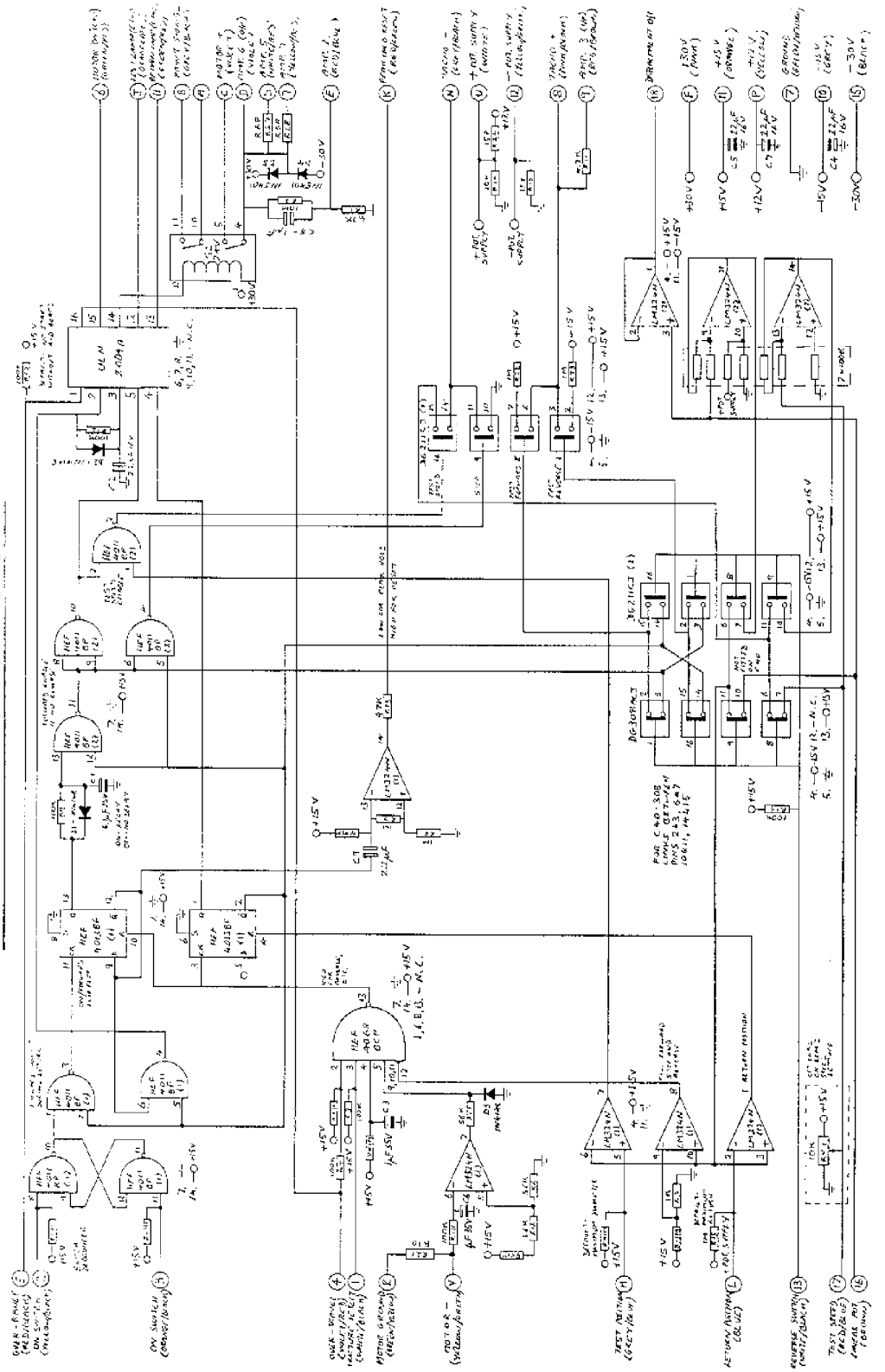


Figure 9

D.C. Power Supply Board Circuit Diagram (ESB 17A 8704)

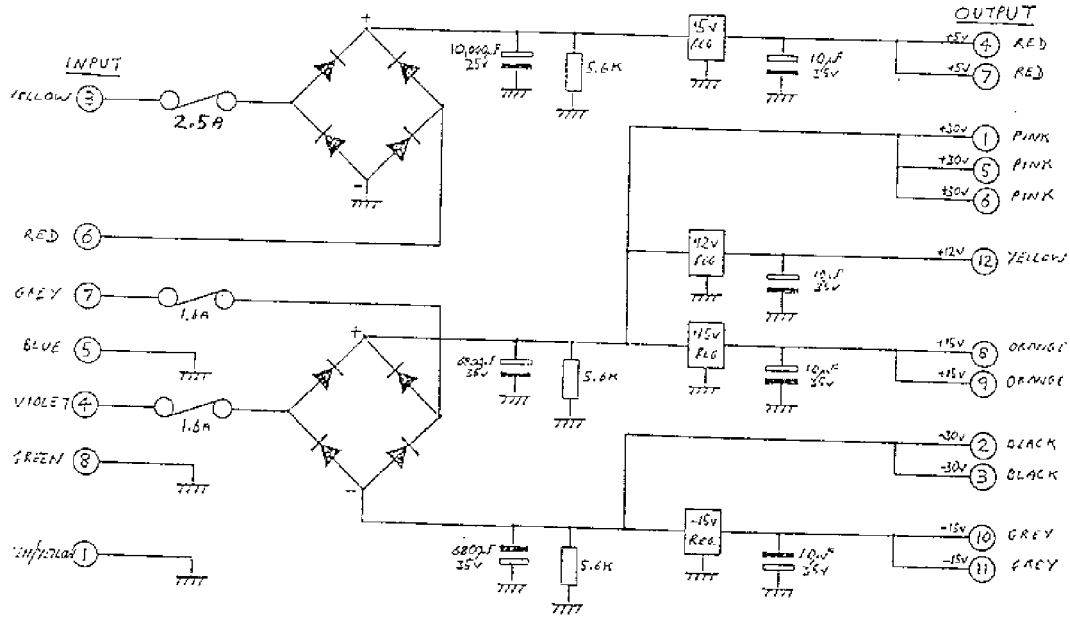


Figure 10

Speed and Position Control Board Circuit Diagram (ESB 16D 8717)

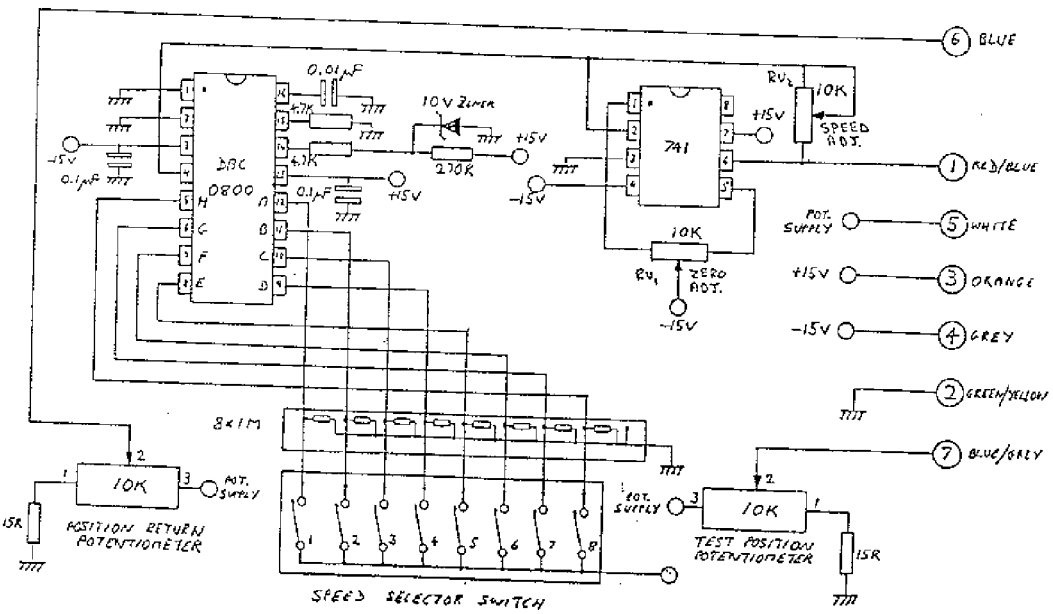


Figure 11

9. Maintenance and repair

Routine maintenance is unnecessary except for care of the load frame gearing and motor gearing, these should be inspected after a period (2 years, depending on usage) and lightly re-greased if necessary. Suggested grease:- ROCOL MTS 1000. If faults cannot be easily traced, contact Engineering Systems.

Important:- If the rubber seal behind the loading anvil is damaged it must be replaced promptly, as tablet chippings etc. can fall into the load cell; this may upset the load cell mechanism and cause erroneous results.

Warning:- Only qualified personnel should be allowed to check for faults if any of the outer casing has been removed and the mains supply is connected. (See **CAUTION** under 2.1)

9.1 FAULTS/SYMPTOMS/CURES etc.

Simple faults such as - 'nothing happens when the machine is switched on' can usually be cured by anyone who knows how to change a fuse. However the ability to cure the more subtle or elusive faults requires some understanding of how the machine works. The following diagram shows how the CT40/C40 operates :-

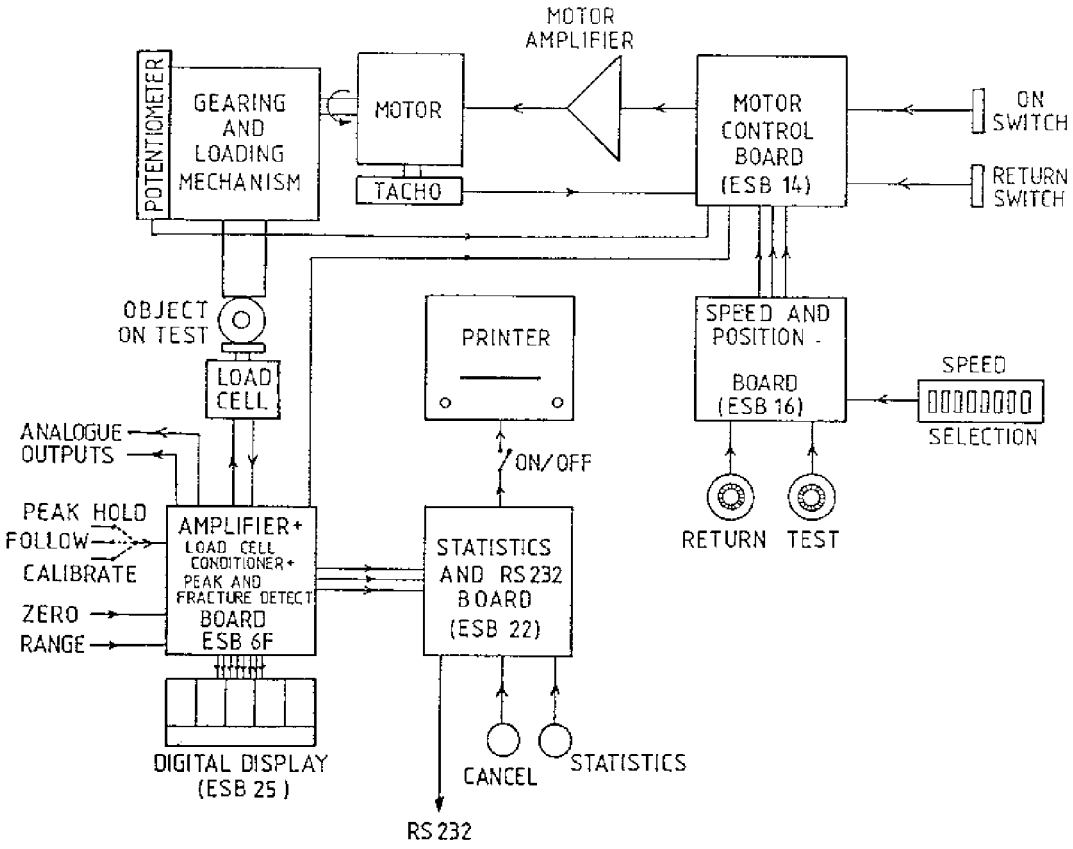


Figure 12

This self explanatry diagram is drawn in 'an anti-clockwise direction of operation', starting with the RETURN, TEST, SPEED & ON controls and ending in the centre with the PRINTER.

The preceding picture is not quite the whole story as low voltage D.C. POWER has to be supplied to the various components and boards. The following diagram completes the picture.

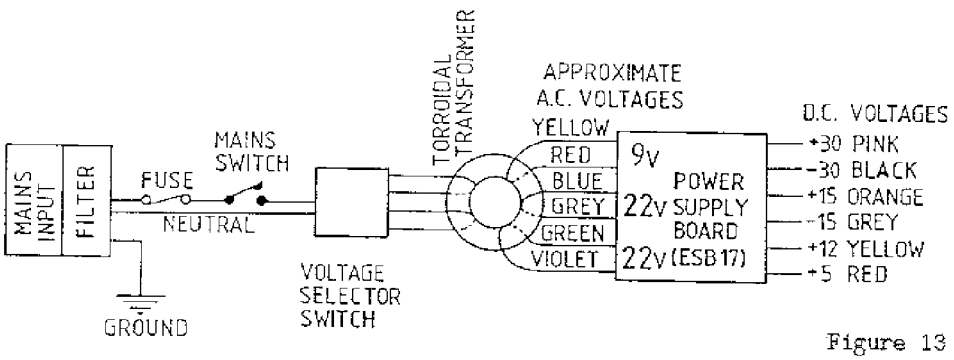


Figure 13

This diagram reads left to right, and shows how the mains input voltage is FILTERED, FUSED, TRANSFORMED and finally CONVERTED into the required D.C. VOLTAGES.

Once the preceding information has been understood fault finding can begin - The machine is MODULAR i.e. built of larger easily replaceable units onto which the many smaller components are mounted. There are approx 8 easily replaceable main modules which are fitted above and below the BASEPLATE to which the wiring loom and other fixed (but replaceable) items are attached. There are basically two types of faults which can occur - MECHANICAL or ELECTRICAL.

The main replaceable modules are :-

MECHANICAL	Gearing & Loading mechanism, including the sub-modules, Motor + tacho, Load Cell, Linear Positioning Potentiometer.
ELECTRICAL	Torroidal Transformer.
ELECTRONIC	Power Supply board, Amplifier + Digital Display boards, Statistics + RS232 board, Speed and Position board, Motor Control board, Printer.

9.1.1 **FIRST STEPS IN FAULT FINDING**
Think logically about the nature of the fault - is it likely to be electrical or mechanical? Faults can usually be isolated into small areas. Perseverance is necessary when tracing INTERMITTANT faults

9.1.2 **ELECTRICAL & ELECTRONIC FAULTS** - It is important to realise that one does not need to be an expert in electronics to cure 'modular electronic faults'. In fact one does not need to know anything at all about electronics to be able to change a board and cure an electronic fault. However fault finding is not always plain sailing and to cure those subtle faults an awareness of electronics will be needed.
Personal STATIC DISCHARGE can damage some of the electronic circuitry and care should be observed when handling the electronic boards. Ideally static free areas should be used, but in practise this is not always possible. Minimum handling, of the edges only, of the boards should help to overcome the static discharge problem.

9.1.3 **GENERAL FAULTS**
FUSES - Check fuses as described in section 2 of the handbook.
POWER SUPPLY - Are the correct voltages being supplied to, and being supplied by, the power supply board? A voltmeter will be needed to check this. The wiring diagram gives the A.C. input and D.C. output voltages which should appear on the power supply board. Cure - replace the power supply board or the torroidal transformer

CONNECTIONS - check, visually and by wiggling, that all electrical connections, plugs, sockets and board inter-connections etc. are properly connected. Check also for 'loose' wires and loose soldered connections anywhere and that the M3 nut at the top of the 'EARTH WIRE PILLARS' is tight. Check for loose foreign bodies, especially of metal, which may short out a circuit board. Check for continuity between connecting boards especially where there is a connector fitted between boards.

BOARD CHANGING It may be that an internal supply voltage fault caused the failure, therefore it would be prudent to check all power supply voltages before changing boards.
If it is suspected that a fault lies within a particular board, replace it with a spare board (module). However if a spare is not available and an electronics workshop is available it may be possible to repair boards 'in house'. Otherwise a spare will have to obtained from the manufactures or the machine sent back for repair.

9.1.4 **MECHANICAL FAULTS** are usually more easy to find than electronic faults. Unplug the mains supply and remove the outer cover(s). A close visual inspection quite often reveals the fault which may be minor and easy to cure, or major and disasterous! Check the tightness of all 'nuts & bolts' etc, remove the small top rear gear guard (two posidrive screws) and check the gears for tightness. Now try connecting the mains and pressing the start button listen for and isolate any peculiar noises.

9.1.5 **SPECIFIC FAULTS**

MOTOR will not start - Are the return & test controls in the correct position, i.e. is the test control 'less' than the plunger (or crosshead) position?
Are the speed switches set to non-zero?
Faulty control board.
Faulty speed board.
Faulty motor amplifier.
Faulty Motor

MOTOR starts but no plunger or crosshead movement - Gears slipping.

FUSES blow on switch on, check that anti-surge (slow blow) fuses are being used.

TEST button bulb does not illuminate - replace bulb.

DISPLAY does not light up - check fuses especially the 2A fuse on the power supply board. These fuses must all be of the anti-surge or slow-blow type

DISPLAY will not zero - Check peak hold/calibrate switch is in it mid-position.
Check load cell platten is not obstructed.
Fault with load cell, is there a possibility that the load cell has been overloaded? check for linerarity etc. with the calibrating weights.

DISPLAY flashes '0',s - load cell not plugged in or leads damaged.
Amplifier board fault.

DISPLAY will not settle to a constant value - analogue board faulty.
Load cell or connections faulty.

DISPLAY jumps up a few digits when peak/hold is switched on - incorrect internal adjustment of trimmers on peak hold chip on analogue board.

PRINTER not working correctly, Check that statistics board (above display is, properly mated with the analogue board connector and that the rear, (8 way, 6 wires) connector is connected correctly. Check that the position of the setting switches on lever switch No.1 is correct and have not been inadvertently changed. Replace printer if a spare is available.
Replace statistics board if a spare is available.
If possible check that the RS232 output is working correctly, if this works the fault is unlikely to be on the statistics board as there is only a small amount of extra circuitry on this board to drive the printer.

TIME & DATE incorrect- adjust as described in section 5.3.3. If the clock will not adjust, is it approaching the limit of the internal battery life (10 years)? Cure- renew the 'clock chip' no. DS1216 which is situated on the statistics board underneath the RAM.

NOTE : various internal trim adjustments, on the analogue board, are set before leaving the manufacturers. These settings should never alter - but - if for any reason they change, the operation of the machine will be upset. Section 4 in this handbook gives details of the majority of adjustments which can be made. If malfunction is still suspected, return the analogue board to the manufactures for complete readjustment.

If the sequence of operations in performing or simulating a test is carried out too quickly, apparent faults may occur.

9.2 **Repair**

Instrument Mechanics and/or Electronic Engineers should have no difficulty in replacing any of the major modules, which are all available as spares, and are detailed in the spares price list.

10. **Guarantee**

The guarantee operates for one year from delivery date and covers failure due to defective components, materials, workmanship but not failure due to misuse or accidental damage. Defective components or machines should be returned to the address below where they will be examined and wholly or partially replaced if necessary.

Manufactured in England by :-
Engineering Systems (Nottm)
1 Loach Court,
Radford Bridge Road,
Nottingham. NG8 1NB

10. **NOTES:**